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February 1988

Study of Differences in Hybrid III Chest Deflections Due to Three-and Two-Point Belt Loadings

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16. Abstract

Parametric studies were performed using the MVMA 2D crash victim simulation program to determine how chest deflection of two point and three point belt-restrained Hybrid III type dummies are affected by belt characteristics, seat cushion geometry and stiffness, floor board and knee cushion locations. Output parameters include hip motion, belt loads, chest deflection (top and bottom), knee loads, belt angles and chest g's. Results of the study indicate that chest deflection for comparable belt geometries are larger for two point belt systems than they are for three point belt systems, and that in all cases the deflection at the bottom of the chest when restrained by a two point belt system is significantly larger than at the top of the chest.

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This letter describes the work that has been done under Order No. DTNH22-87-P-02088, "Study of Differences in Hybrid III Dummy's Chest Deflections Due to Three- and Two-Point Belt Loadings." Under this Order, UMTRI has adapted the Hybrid III dummy's chest deflection characteristics to the MVMA2D crash victim simulation program and performed parametric studies to determine how chest deflection of two-point and three-point belt-restrained dummies are affected by belt properties, seat cushion geometry and stiffness, floor board and knee cushion locations.

DATA RESOURCES

Four information sources were used in developing the data sets for this study. The first of these was used to obtain vehicle interior geometric data. The Volkswagen Rabbit vehicle interior, occupant posture, H-point location, and two-point belt geometry were obtained from previous work conducted at UMTRI reported in "Biomechanical Accident Investigation Methodology." This report, authored by D. H. Robbins, J. W. Melvin, D. F. Huelke, and H. W. Sherman, was the output from a project sponsored by MVMA that was completed in 1983. The vehicle data were obtained from seating package drawings supplied by Volkswagen of America. They were used in the successful reconstruction of an offset head-on crash between a 1979 Blazer and a 1980 VW Rabbit. Both occupants of the Rabbit were wearing automatic shoulder belts.

The second data source was used to replace the human data used in the accident reconstruction with Hybrid III parameters. The source for the Hybrid III parameters in MVMA2D format was a data set provided by General Motors to NHTSA for general use.

The third data source was used to replace the vehicle deceleration estimated for the crash reconstruction mentioned above. The new barrier crash pulse that was used was obtained at TRC.

The fourth, and final, data source provided upgraded advanced three-dimensional belt geometry developed from concepts used in a recent study conducted for industry.

METHOD FOR DETERMINING CHEST DEFORMATION

Figures 1 and 2 show the geometry of the model which is used to estimate chest deflection from MVMA2D simulation output. Two configurations of the torso belt crossing the chest are shown in Figure 1. The first (solid line) is the path over the chest for the MVMA2D simulation. This reflects the fact that the belt is attached to points on the chest which cannot move with respect to the chest center of gravity. The second (dotted line) shows the path the belt would take over the torso if chest deflection is allowed. The displacement at the top of the chest is shown to be different from the displacement at the bottom. In order for dummy kinematics predicted by the MVMA2D model to match test data that includes Hybrid III chest deformation, it is necessary to reduce belt stiffness for the computer simulation to allow more belt stretch for the same applied force.

Figure 2 shows details of belt and chest deformation and the effect of applied forces on both. The upper and lower belts as well as the chest are shown as free bodies. Elongation of all belts includes the effects of the applied forces on the upper and lower sections. An additional elongation is included for the MVMA2D model simulation to take into account the effect of chest deflection. This additional elongation effect depends on both belt angle and the deflection at the top and bottom of the chest. The assumption has been made that the difference in belt angle is small between the MVMA2D and test conditions. Different stiffnesses have been assigned to the top and bottom of the chest to test the hypothesis that Hybrid III dummy chest deflection may have more than one degree of freedom (at a minimum, rotational as well as uniaxial motion).

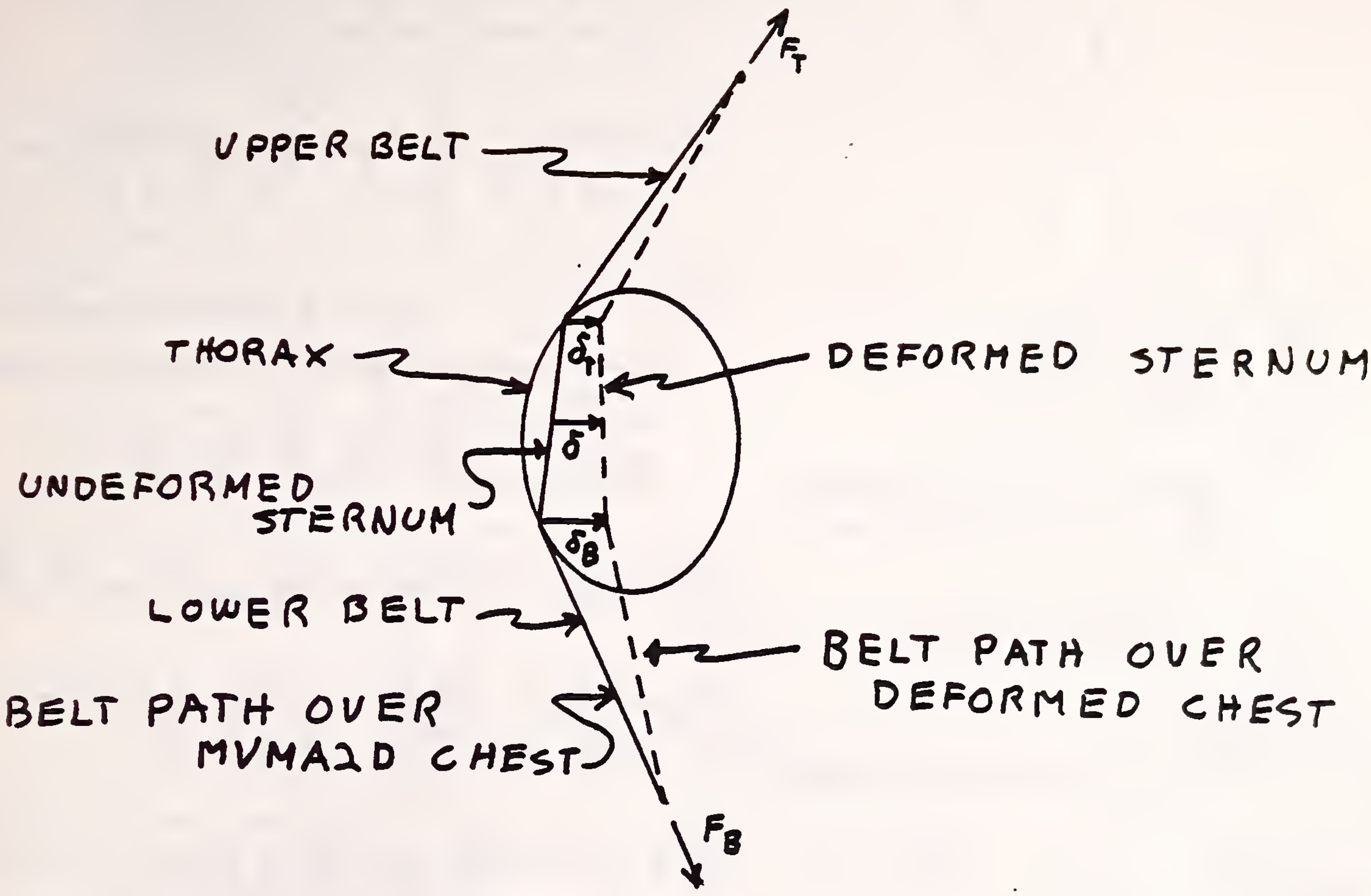
The geometric model that has been presented can now be used to develop a method for using the unmodified MVMA2D model to predict differential chest deflections. The first step is to make a major assumption that both belt and chest stiffnesses can be modeled by linear springs as is done in the following simplistic analysis. The belt force components normal to the chest are related to the displacements at its top, bottom, and center by the equations,

$$F_T \cos\theta_T = k_T \delta_T$$

$$F_B \cos\theta_B = k_B \delta_B$$

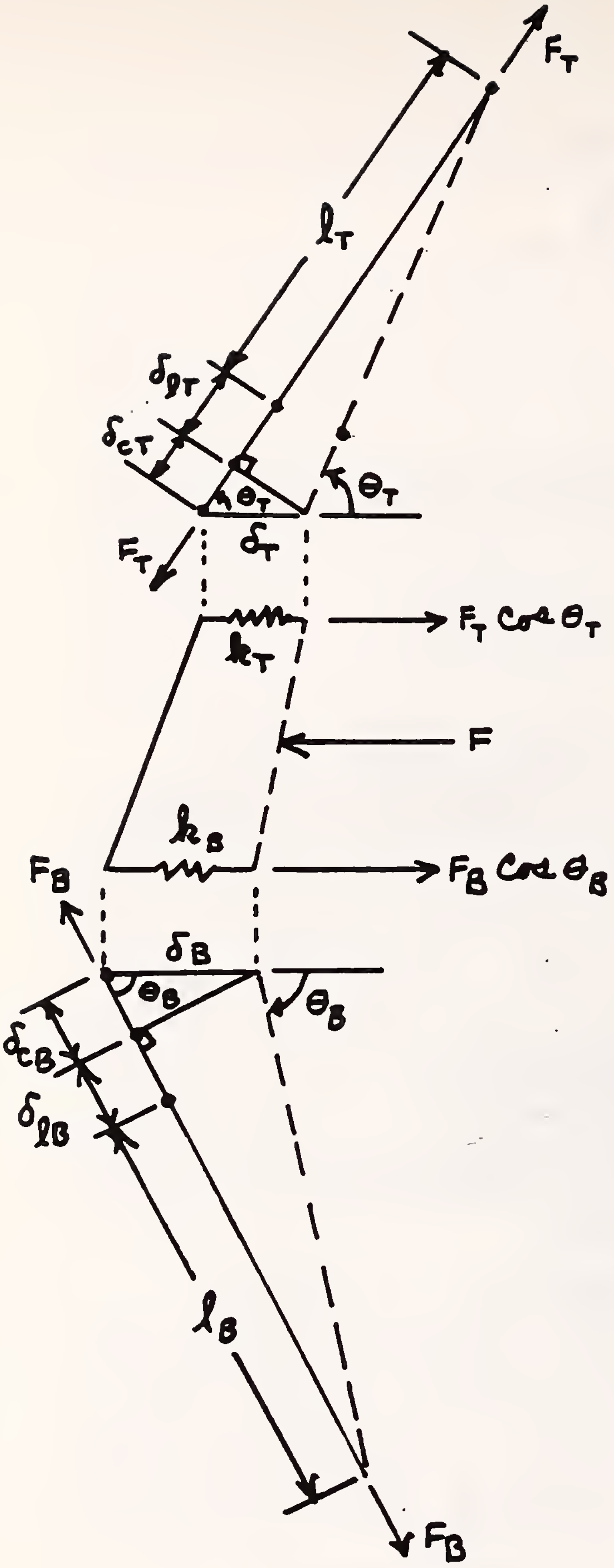
$$F = F_T \cos\theta_T + F_B \cos\theta_B$$

$$F = k_c \delta = k_T \delta_T + k_B \delta_B = k_c \left(\frac{\delta_T + \delta_B}{2} \right)$$



δ_T = deflection at top of sternum
δ = mid-sternum deflection
δ_B = deflection at bottom of sternum
F_T = force in upper belt
F_B = force in lower belt

Figure 1. Schematic of MVMA2D model of belt path over chest with effect of chest deformation superimposed.



l_T and l_B = unstretched length of upper and lower belts

δ_{lT} and δ_{lB} = elongation of belt due to belt force, F_T and F_B.

δ_{CT} and δ_{CB} = added belt elongation to account for chest compression within limits of MVMA 2D belt model (fixed to torso).

θ_T and θ_B = Belt angles with vertical

k_T and k_B = Stiffnesses at top and bottom of chest

F = overall reaction force of sternum to applied belt forces

δ_T and δ_B = deflections at top and bottom of chest.

F_T and F_B = Forces acting on upper and lower belt segments

Figure 2. Details of belt and chest deformation and the effects of the applied forces.

where k_c is the overall chest stiffness. If the compliances at the top and bottom of the chest are the same,

$$k_T = k_B = k$$

$$k_c \left(\frac{\delta_T + \delta_B}{2}\right) = k\,(\delta_T + \delta_B)$$

$$k_c = 2k$$

Note from Figure 2 that the MVMA2D belt elongation effect due to chest deflection can be expressed in terms of chest deflection as,

$$\delta_{cB} = \delta_B \cos\theta_B$$

$$\delta_{cT} = \delta_T \cos\theta_T$$

The force-deflection equations can now be written,

$$F_T \cos\theta_T = \frac{k_c}{2}\delta_T = \frac{k_c}{2}\,\frac{\delta_{cT}}{\cos\theta_T}$$

$$F_B \cos\theta_B = \frac{k_c}{2}\delta_B = \frac{k_c}{2}\,\frac{\delta_{cB}}{\cos\theta_B} \qquad (1)$$

In terms of either belt force, or deflection in the belt, they can be rewritten as,

$$\delta_{cT} = \frac{2\cos^2\theta_T}{k_c}F_T \quad ; \quad \delta_{cB} = \frac{2\cos^2\theta_B}{k_c}F_B$$

$$F_T = \frac{k_c}{2\cos^2\theta_T}\delta_{cT} \quad ; \quad F_B = \frac{k_c}{2\cos^2\theta_B}\delta_{cB} \qquad (2)$$

These simplistic equations illustrate the interacting effects of chest stiffness, belt angle, and belt properties for given belt forces. If belt angle is zero, then the entire belt force is applied to chest deformation. As the belt angle increases toward 90 degrees, the effect becomes less. Different belt angles at the top and bottom of the chest can clearly have a major effect on the loads that are applied to the chest and the chest deflections which result.

Equations 2 provide the information needed to compute the amount of strain that must be added to the MVMA2D belt lengths for inclusion of the effect of Hybrid III chest deflection.

$$F_T = \frac{k_c l_T}{2\cos^2\theta_T}\left(\frac{\delta_{cT}}{l_T}\right) = \frac{k_c l_T}{2\cos^2\theta_T}\epsilon_{cT}$$

$$F_B = \frac{k_c l_B}{2\cos^2\theta_B}\left(\frac{\delta_{cB}}{l_B}\right) = \frac{k_c l_B}{2\cos^2\theta_B}\epsilon_{cB} \qquad (3)$$

These equations define belt stiffness adjustments that include effects of chest deflection, belt angle, and belt length. Belt angle and length are known from the test setup geometry. The equations are used to compute the effects of shared deflection between the belt and the chest for inclusion in the input data for the MVMA2D model (Cards 710 and 711, fields 8 and 9 to define the material names, and cards 704-709 to define material properties).

Chest stiffness is based on post-test dummy calibration thorax impact data from the TRC Volkswagen Rabbit barrier impact mentioned earlier. Assuming a linear force-deflection curve, the chest stiffness is about 418 pounds/inch (5413.8 newtons maximum resistive force and 6.39 centimeters maximum deflection from the test) until geometric restrictions to motion are generated. Because of the "clavicle", only a small amount of deflection at the top of the chest beyond about 2.2 inches can take place. At the bottom of the chest, bottoming out begins to occur at about 3.25 inches. Beyond the points at which bottoming out is assumed to occur, a stiffness value of 12750 pounds/inch is chosen on the basis of data obtained from industry sources. So, up to a point, the bottom of the chest is more compliant than the top.

Equations 1 can be rewritten for use in estimating chest deflections from MVMA2D model output.

$$\delta_T = \frac{2\cos\theta_T}{k_c} F_T \quad , \quad \delta_B = \frac{2\cos\theta_B}{k_c} F_B \qquad (4)$$

Belt angle, belt force, and chest stiffness are all known. Maximum values of belt angles and forces are obtained from the MVMA2D output while different chest stiffnesses are used for the top and bottom of the chest. A short program in BASIC was written to compute the deflections from the MVMA2D output.

A final comment should be made about an assumption made in this analysis which is clearly illustrated in Figure 2. The computations are based on forces and deflections normal to the surface of the chest. The drawing correctly shows a surface line of the chest which is not normal to either deflection or force. The results will be most accurate when the torso is essentially upright during the application of crash loads. The predictions using this analysis are intended to show performance trends rather than quantitative results. To determine the accuracy of the procedure, validation against experimental results will be required.

MATRIX OF COMPUTER RUNS

Parameter studies have been conducted to determine how chest deflection of two-point and three-point belt-restrained dummies are affected by belt properties, seat cushion geometry and stiffness, as well as floor board and knee bolster locations. The following variations to the baseline two-point and three-point belt data sets have been made:

- Knee bolster moved 2 inches toward the front of the vehicle. Knee bolster moved 1.85 inches toward the occupant to almost touch the knees.
- Toeboard moved 4 inches toward the front of the vehicle.
- Knee bolster moved 2 inches toward the front of the vehicle and toeboard moved 4 inches toward the front of the vehicle.
- Upper torso belt anchor moved 4 inches toward the rear of the vehicle.
- Lower torso belt anchor (lap belt in the case of the three-point belt) moved 4 inches toward the rear of the vehicle and moved 4 inches toward the front of the vehicle.
- Both upper and lower belt anchors moved 4 inches toward the rear of the vehicle
- Belt stiffness reduced by a factor of 0.5
- Seat cushion stiffness reduced by a factor of 0.5
- Seat cushion friction set to 1.0
- Belt slack increased to 3.5 inches

The baseline data sets are included as Appendices A and B at the end of this letter report.

SUMMARY OF RESULTS

Tables 1 through 4 are a summary of the results obtained from the computer runs. A total of 44 computer runs were made. The earliest and most time consuming were those conducted while assembling data from the various data resources discussed previously. A total of 26 computer runs are included in the tables. A coding for the various runs is given as follows:

- 2 Pt Base. The baseline run for the two-point passive belt system.

- Bols+2. The entire bolster structure is moved forward 2 inches.

- Bols-1.85. The entire bolster structure is moved to nearly touch the occupant's knees.

- UT Anch-4. The anchor in the vehicle for the upper torso belt is moved 4 inches to the rear.

- LT Anch-4. For the two-point belt, the anchor in the vehicle for the lower section of the torso belt is moved 4 inches to the rear. For the three-point belt, the anchor in the vehicle for the stalk is moved 4 inches to the rear.

- LT Anch+4. Same as above except anchor is moved toward the front of the vehicle.

- UT&LT A-4. Both belt anchors are moved 4 inches toward the rear of the vehicle.

- Belt K*.5. The belt stiffness curve is reduced by a factor of 0.5.

- Slack=3.5. Belt slack in the various segments is increased from 1 inch to 3.5 inches.

- Toebo(a)rd+4. The entire toeboard structure is moved 4 inches toward the front of the vehicle.

- SC K*.5. The seat cushion stiffness curve is reduced by a factor of 0.5.

- SC Fric=1. The seat cushion friction coefficient is increased from 0.2 to 1.0.

- Bol+2,TB+4. The bolster and toeboard are moved toward the front of the vehicle by 2 inches and 4 inches respectively.

Table 1. Summary of Hip Motion, Femur Load, Chest Deceleration, and Chest Deflection Output (Two-point belts).

Variation	Hip X (in)	Hip Z (in)	Femur load (lb)	Chest G's	Upper chest defl. (in)	Lower Chest defl. (in)
2 Pt Base	6.43	1.14	4114	55.7	2.53	3.33
Bols+2	8.43	0.50	4850	66.2	2.59	3.37
Bols-1.85	4.24	1.74	3188	50.9	2.48	3.31
UT Anch-4	6.43	1.17	4107	54.0	2.51	3.32
LT Anch-4	6.32	1.02	4074	56.3	2.54	3.37
LT Anch+4	6.56	1.25	4162	54.2	2.51	3.29
UT&LT A-4	6.32	1.05	4068	55.6	2.52	3.35
Belt K*.5	6.59	1.22	4179	50.0	2.44	3.30
Slack=3.5	6.67	1.23	4626	59.2	2.49	3.32
Toebord+4	6.41	1.15	4157	55.6	2.53	3.33
SC K*.5	6.68	1.74	4210	56.2	2.53	3.34
SC Fric=1	5.91	1.24	4120	56.7	2.54	3.34
Bol+2,TB+4	8.34	0.47	4698	65.7	2.59	3.37

Table 2. Summary of Hip Motion, Femur Load, Chest Deceleration, and Chest Deflection Output (Three-point Belts).

Variation	Hip X (in)	Hip Z (in)	Femur load (lb)	Chest G's	Upper chest defl. (in)	Lower chest defl. (in)
3 Pt Base	5.62	2.10	3119	47.6	2.39	2.88
Bols+2	7.19	1.76	2850	59.4	2.46	3.26
Bols-1.85	3.86	2.35	2608	41.8	2.35	2.37
UT Anch-4	5.62	2.11	3108	47.8	2.39	2.76
LT Anch-4	5.20	2.09	2753	49.2	2.40	3.27
LT Anch+4	6.13	2.01	3581	48.0	2.38	1.94
UT&LT A-4	5.20	2.09	2744	49.9	2.40	3.26
Belt K*.5	6.06	1.78	3587	38.1	2.31	2.21
Slack=3.5	6.62	1.40	4215	47.6	2.33	2.71
Toebord+4	5.60	2.11	3193	47.3	2.39	2.84
SC K=.5	5.66	2.75	3195	47.3	2.39	2.91
SC Fric=1	5.37	1.92	3307	51.4	2.40	2.92
Bol+2,TB+4	7.08	1.78	2908	59.1	2.45	3.26

Table 3. Summary of Belt Output (Two-point Belts).

Variation	Up Belt Load (pounds)	Up Belt Angle (degrees)	Lo Belt Load (pounds)	Lo Belt Angle (degrees)
2 Pt Base	2661	14.44	2022	51.71
Bols+2	3079	14.03	2340	50.51
Bols-1.85	2388	15.35	1815	53.19
UT Anch-4	2520	12.18	1915	51.82
LT Anch-4	2714	14.74	2062	44.90
LT Anch+4	2546	13.99	1935	59.92
UT&LT A-4	2569	12.38	1952	44.95
Belt K*.5	2059	13.42	1565	49.57
Slack=3.5	2372	12.78	1803	48.68
Toeboard+4	2658	14.44	2020	51.73
SC K*0.5	2676	15.48	2034	50.24
SC F=1.0	2716	13.95	2064	52.19
Bol+2,TB+4	3073	14.00	2335	50.58

Table 4. Summary of Belt Output (Three-point Belts).

Variation	Up Belt Load (pounds)	Up Belt Angle (degrees)	Lo Belt Load (pounds)	Lo Belt Angle (degrees)
3 Pt Base	1777	15.13	1351	61.79
Bols+2	2192	14.93	1666	61.32
Bols-1.85	1490	15.48	1133	62.30
UT Anch-4	1752	12.67	1331	62.62
LT Anch-4	1844	15.63	1402	54.33
LT Anch+4	1670	14.26	1269	70.20
UT&LT A-4	1815	13.02	1379	54.39
Belt K*0.5	1196	13.89	909	57.35
Slack=3.5	1379	12.38	1048	54.93
Toeboard+4	1771	15.13	1346	62.05
SC K*0.5	1767	16.05	1343	61.28
SC Fric=1.	1818	14.50	1382	61.99
Bol+2,TB+2	2160	14.92	1641	61.33

OBSERVATIONS

The following six output parameters were included in the results given in Tables 1 - 4:

- Hip motion
- Belt loads
- Chest deflection (top and bottom)
- Knee loads
- Belt angles
- Chest G's

Observations of the effects of the various parameter variations on these quantities follow.

1. Hip motion. The X-motion of the hip is the smallest when the bolster is positioned closest to the knees. Likewise, it is the largest when the bolster is located furthest away. Conversely, the Z-motion is greatest when the bolster is closest, and also, when the seat cushion is softest. The hip X-motion is greater for two-point systems than it is for three-point systems. The converse is true for Z-motion.

2. Belt loads. Torso belt loads are largest when the bolster is positioned the furthest from the knees. This is due to the fact that the chest begins to absorb energy before the knees. Torso belt loads are lower when the bolster is closest and when belt slack is greatest. The reason for improved performance with an increase in belt slack in this case is the improved phasing of loads applied to the torso and hip. The smallest loads are applied in the case of the smallest belt stiffness. Loads in the two-point belt systems are larger than those in the three-point belt system.

3. Chest deflections. Chest deflections are larger for the two-point belt systems than they are for the three-point belt systems at both the top and the bottom of the chest. Lower chest deflection values are similar to, or larger than, upper chest deflection values for three-point belt loading. This depends on bolster and lower belt anchor locations. Forward belt anchor locations and bolsters positioned close to the knees result in deflections at the bottom of the chest which are similar in value to those at the top of the chest. In all cases with the two-point belt system, the deflection at the bottom of the chest is significantly larger than that at the top. This effect is accentuated by the blocking effect of the clavicle structure in the Hybrid III against an increase of belt angle as the dummy moves forward.

4. Knee loads. Knee loads are significantly lower for the three-point belt systems because the belts absorb a significant portion of the crash loading on the occupant.

5. Belt angles. The significantly larger angle of the lower torso element in the two-point belt system results in a larger force component normal to the surface of the chest than is the case with the three-point belt systems.

6. Chest G-loading. Chest G's are larger for two-point belts. This reflects the larger loads which are applied. The lowest loads are for the case of belts with reduced stiffness properties. The largest loads occur when there is a time delay before the occupant interacts with the vehicle. In these cases, the bolster is further from the knees or there is slack in the belt system.

APPENDIX A

TWO-POINT BELT SYSTEM
BASELINE DATA SET

```
DOTVW3                                                                                  100
1.        0.        32.174    0.        0.        150.      .5        1.        10.     101
3.        0.        0.        0.        0.        0.        10.       .000001   5.      102
FDOT                FLOOR                                                               1D6
CHEST               STEERING WHEEL                                                      106
CHEST               SEATBACK                                                            106
MIO-TDRSO           STEERING WHEEL                                                      106
HIP                 CUSHION                                                             106
ULEG                CUSHION                                                             106
LARM                STEERING WHEEL                                                      1D6
MID-TDRSO           SEATBACK                                                            106
HEAO                RDDF                                                                106
LARM                INST.PANEL                                                          106
HEAD                STEERING WHEEL                                                      106
ULEG                BDLSTER                                                             106
S1SHIN              BDLSTER                                                             106
S2SHIN              BDLSTER                                                             106
S3SHIN              BDLSTER                                                             106
HEAD                INST.PANEL                                                          106
HEAD                WINDSHIELD                                                          106
0.        1.        1.        0.        0.        0.        0.        0.        0.      107
0.        0.        0.        0.        0.        0.        0.        0.        1.      108
1.        1.        0.        0.        0.        0.        0.        0.        0.      109
0.        0.        0.        0.        0.        1.        1.        1.        1.      110
0.        0.        0.        0.        0.        0.        0.        0.        0.      111
  HYBRID 3 DUMMY                                                                        200
.477      11.573    5.109     3.722     15.815              10.3      2.993     -.657   201
1.883     6.165     2.55      2.306     9.445     9.45      5.143     5.95      .1434   202
.0258     .098      .0328     .0984     .0691     .0535     .0226     .0259     .0087   203
.253      1.917     .428      1.286     1.202     3.038     .204      .632      .D53    2D4
44.236    123.861   0.        .39812    17.394    10.                 -60.      .75     205
44.236    123.861   0.        .39812    17.394    10.                 -9D.      .75     206
884.72    0.        0.        .69981    884.82    400.      20.       -50.      .75     207
102.4729-7.62075.1943356.69981          884.72    400.      -43.      -83.      .75     208
84.40653-4.80841.10522580.              884.72    400.      0.        -120.     .75     2D9
0.        29.815    0.        0.        221.18    100.      135.      0.        .75     210
24.391710.          .00645400.          221.18    100.      30.       -180.     .75     211
12.191430.          .00645400.          309.65    100.      3.        -145.     .75     212
4566.32   0.        0.        37.101                                                    213
684.95    0.        0.        8.0767                        1.575               1.      214
4.061     13.271    0.        .1106     19.703    8.        46.                 .8      215
4.061     17.517    0.        .0531     74.872    30.       21.5                .8      216
-15.1     -11.2     -14.2     -39.      -43.6     74.       -38.3     -63.              217
1.898     6.2       0.                                                                  218
HEAD                                    1.        1.                                    219
CHEST               CHESTMAT            2.        1.                                    219
SLDR                                    2.        1.                                    219
MID-TDRSD           CHESTMAT            3.        1.                                    219
HIP                                     4.        1.                                    219
ULEG                                    5.        1.                                    219
KNEE                                    5.        1.                                    219
S1SHIN                                  6.        1.                                    219
S2SHIN                                  6.        1.                                    219
S3SHIN                                  6.        1.                                    219
FOOT                                    6.        1.                                    219
JAW                                     1.        1.                                    219
UARM                                    7.        1.                                    219
ELBOW                                   7.        1.                                    219
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 59   LARM                               8.       1.                                  219
 60   HAND             EC3MAT            8.       1.                                  219
 61   HEAO             .276     -.039    4.4      3.907                               220
 62   CHEST            -1.299   0.       4.872    4.528                               220
 63   SLOR             -5.187   0.       .984     2.559                               220
 64   MID-TORSO        -2.047   -1.063   4.331    4.331                               220
 65   HIP              .866     .63      4.134    4.134                               220
 66   ULEG             -.394    .591     8.346    2.953                               220
 67   KNEE             6.693    .157     2.421    2.421                               220
 68   S1SHIN           -4.646   .287     2.323    2.323                               220
 69   S2SHIN           -.287    .571     2.075    2.075                               220
 70   S3SHIN           3.575    .528     1.61     1.61                                220
 71   FOOT             6.811    -.055    4.724    4.724                               220
 72   JAW              3.937    -1.772   .787     1.772                               220
 73   UARM             -1.535   0.       4.665    2.028                               220
 74   ELBOW            5.039    .0787    1.929    1.929                               220
 75   LARM             -.0787   0.       4.035    1.821                               220
 76   HAND             6.339    0.       1.821    1.821                               220
 77   CHESTMAT         .1969    .866     0.       39.37    39.76    0.       0.        221
 78   CHESTMAT         33.7     0.       0.       0.       CHESTST I          CHESTGR   222
 79   CHESTGR 0.       0.                                                             223
 80   CHESTGR .394     .2                                                             223
 81   CHESTGR .866     .275                                                           223
 82   CHESTGR 1.575    .275                                                           223
 83   CHESTGR 2.756    .357                                                           223
 84   CHESTGR 0.       1.                                                             224
 85   CHESTGR .394     .48                                                            224
 86   CHESTGR .866     .356                                                           224
 87   CHESTGR 1.575    .352                                                           224
 88   CHESTGR 2.756    .218                                                           224
 89   CHESTST 0.       0.                                                             225
 90   CHESTST .394     1191.                                                          225
 91   CHESTST .866     1965.                                                          225
 92   CHESTST 1.575    2739.                                                          225
 93   CHESTST 2.756    5947.                                                          225
 94   EC3MAT           0.       0.       0.       39.37    39.76    0.       0.        221
 95   EC3MAT           3.37     0.       0.       0.       EC3STAT I          EC3GR     222
 96   EC3GR    -1.     .08                                                            223
 97   EC3GR    -1.     .91                                                            224
 98   EC3STAT 0.       .05                                                            225
 99   EC3STAT 1.5      530.                                                           225
100   EC3STAT 3.       1359.                                                          225
101   EC3STAT 3.6      1812.                                                          225
102   EC3STAT 12.      22472.                                                         225
103   I        -1.     0.                                                             226
104   685.     0.      0.       9.047                                                 242
105      HYBRID 3 DUMMY.                                                              300
106   74.9     101.2   115.4    154.4    18.      -56.     -40.5    22.5     90.      301
107   -6.15    0       -12.15   0.       5.73     0.                                  303
108   0.       0.      0        0.                                                    304
109   VEHICLE INTERIOR                                                                400
110   FLOOR            MATFL             0.       1.       1.       1.                401
111   INST PANEL       MATDASH           0.       1        1.       1.                401
112   BOLSTER          MATBOL            0        1        1.       1.                401
113   WINDSHIELD       MATWD             0.       1        1.       1.                401
114   CUSHION          MATCH             0        1.       1.       1.                401
115   SEATBACK         MATSB             0        1        1.       1.                401
116   ROOF             MATRF             0.       1        1.       1.                401
```

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   117      STEERING WHEEL  MATSTW          0.       1.       1.       1.                        401
   118      FLOOR           2.       4.     1.       0.       0.                                 402
   119      INST.PANEL      2.       2.     1.       0.       0.                                 402
   120      BOLSTER         1.       2.     1.       0.       0.                                 402
   121      WINDSHIELD      1.       1.     1.       0.       0.                                 402
   122      CUSHION         1.       3.     1.       0.       0.                                 402
   123      SEATBACK        1.       2.     1.       0.       0.                                 402
   124      ROOF            1.       2.     1.       0.       0.                                 402
   125      STEERING WHEEL  1.       5.     1.       0.       0.                                 402
   126      MATFL           0.       0.     0.       1000.    2000.    2400.    8000.             403
   127      MATDASH         0.       0.     0.       1000.    2000.    0.       0.                403
   128      MATBOL          0.       0.     0.       1000.    2000.    0.       0.                403
   129      MATWD           0.       0.     0.       1000.    2000.    0.       0.                403
   130      MATCH           0.       0.     0.       1000.    2000.    0.       0.                403
   131      MATSB           0.       0.     0.       1000.    2000.    0.       0.                403
   132      MATRF           0.       0.     0.       1000.    2000.    0.       0.                403
   133      MATSTW          0.       0.     0.       1000.    2000.    0.       0.                403
   134      MATFL           2.       0.     0.       0.       FLSTAT   INERZ    FLGR              404
   135      MATDASH         2.       0.     0.       0.       DASHSTATINERZ    DASHGR            404
   136      MATBOL          2.       0.     0.       0.       BOLSTAT  INERZ    BOLGR             404
   137      MATWD           2.       0.     0.       0.       WDSTAT   INERZ    WDGR              404
   138      MATCH           2.       0.     0.       0.       CHSTAT   INERZ    CHGR              404
   139      MATSB           2.       0.     0.       0.       SBSTAT   INERZ    SBGR              404
   140      MATRF           2.       0.     0.       0.       RFSTAT   INERZ    RFGR              404
   141      MATSTW          2.       0.     0.       0.       STWSTAT  INERZ    STWGR             404
   142      FLGR     -1.    .2                                                                   405
   143      FLGR     -1.    .2                                                                   406
   144      DASHGR   -1.    .8                                                                   405
   145      DASHGR   -1.    .08                                                                  406
   146      BOLGR    -1.    .8                                                                   405
   147      BOLGR    -1.    .08                                                                  406
   148      WDGR     -1.    .95                                                                  405
   149      WDGR     -1.    .01                                                                  406
   150      CHGR     -1.    .1                                                                   405
   151      CHGR     -1.    .85                                                                  406
   152      SBGR     -1.    .1                                                                   405
   153      SBGR     -1.    .85                                                                  406
   154      RFGR     -1.    .5                                                                   405
   155      RFGR     -1.    .5                                                                   406
   156      STWGR    -1.    .95                                                                  405
   157      STWGR    -1.    .05                                                                  406
   158      FLSTAT   -1.    800.                                                                 407
   159      DASHSTAT-1.     441.24   -109.64 9.3813   0.17045                                    407
   160      BOLSTAT  0.     0.                                                                   407
   161      BOLSTAT  6.     5400.                                                                407
   162      WDSTAT   -1.    2000.                                                                407
   163      CHSTAT   -1.    122.     37.6    -74.48   22.16                                      407
   164      SBSTAT   -1.    14.      -9.     14.      -4.      1.                                407
   165      STWSTAT  0.     0.                                                                   407
   166      STWSTAT  .1     1562.                                                                407
   167      STWSTAT  .49    1875.                                                                407
   168      STWSTAT  .51    2500.                                                                407
   169      STWSTAT  .75    1875.                                                                407
   170      STWSTAT  1.5    1562.                                                                407
   171      STWSTAT  2.4    1000.                                                                407
   172      STWSTAT  3.9    750.                                                                 407
   173      STWSTAT  8.     750.                                                                 407
   174      STWSTAT  10.    10000.                                                               407
```

```
RFSTAT  0.      0.                                                          407
RFSTAT  2.      2000.                                                       407
RFSTAT  3.      13000.                                                      407
INERZ   -1.     0.                                                          408
FLODR           FLODR           20.     .25     1.      1.                  409
TDEBDARD        FLDDR           20.     .25     1.      2.                  409
BDLSTERD        BDLSTER         4.      .25     1.      1.                  409
MIDDLEDH        INST.PANEL      4.      .25     1.      1.                  409
UPPERDH         INST.PANEL      4.      .25     -1.     2.                  409
WINDSHIELD      WINDSHIELD      1.      .25     1.      1.                  409
CUSHIDN         CUSHION         20.     .25     1.      1.                  409
SEATBACK        SEATBACK        20.     .25     1.      1.                  409
RODF            ROOF            4.      .25     1.      1.                  409
STEERING WHEEL  STEERING WHEEL  2.      .25     1.      1.                  409
FLDOR           1.                                                          410
TDEBDARD        1.                                                          410
BOLSTERD        1.                                                          410
MIDDLEDH        1.                                                          410
UPPERDH         1.                                                          410
WINDSHIELD      1.                                                          410
CUSHION         1.                                                          410
SEATBACK        1.                                                          410
RODF            1.                                                          410
STEERING WHEEL  1.                                                          410
FLOOR           -1.     -15.    12.3    29.7    12.3                        411
TDEBOARD        -1.     29.7    12.3    39.2    0.                          411
BDLSTERD        -1.     17.5    -10.    24.7    2.5                         411
MIDDLEDH        -1.     19.7    -6.3    21.1    -18.8                       411
UPPERDH         -1.     21.1    -18.8   32.     -16.2                       411
WINDSHIELD      -1.     32.     -16.2   15.3    -30.9                       411
CUSHION         -1.     -8.     5.      16.5    -2.5                        411
SEATBACK        -1.     -3.4    5.      -14.2   -20.                        411
ROOF            -1.     16.     -32.9   -16.    -32.9                       411
STEERING WHEEL  -1.     9.7     -6.7    16.6    -20.                        411
1.      1.      0.                                                          412
1.      2.      .7                                                          412
1.      3.      .2      0.                                                  412
1.      4.      .8      .15                                                 412
1.      5.      1.                                                          412
1.      6.      1.                                                          412
CRASH 44.5 FT/SEC                                                           600
0.      44.5    0.      0.      0.      0.      0.      0.      0.          601
17.     1.      0.                                                          602
0.      0.      5.      -1.     7.      -5.     22.     -8.
30.     -23.    35.     -23.    38.25   -45.28  47.     -30.
55.     -30.    60.     -10.    66.     0.      70.     -6.
90.     -12.    95.     -3.     110.    -3.     135.    0.
200.    0.
PASSIVE TORSO BELT                                                          700
BELT            0       0.      0.      1000.   2000.   0.      0.          704
BELT            20.     0.      0.              BLTST   BINERZ  BLTGR       705
BLTGR   -1.     .05                                                         706
BLTGR   -1.     .95                                                         707
BLTST   0       0                                                           708
BLTST   033     1000.                                                       708
BLTST   .125    2500.                                                       708
BLTST   .3      7416.                                                       708
BINERZ  -1.     0                                                           709
```

229.01	H3TOP		0.	0.	0.	1000.	2000.	0.	0.	704
229.02	H3TOP		20.	0.	0.		TOPST	BINERZ	BLTGR	705
229.03	TOPST	0.	0.							708
229.04	TOPST	.06	1000.							708
229.05	TOPST	.07	6000.							708
229.06	H3BOT		0.	0.	0.	1000.	2000.	0.	0.	704
229.07	H3BOT		20.	0.	0.		BOTST	BINERZ	BLTGR	705
229.08	BOTST	-1.	8534.							708
230	2.15	2.4	-16.3	-21.3	1.5	BELT		H3TOP		710
231	12.	3.9	-7.2	10.6	1.5	BELT		H3BOT		711
232	3.	1.	2.	6.57	0.	1.	1.			717
233				1.		50000.	-.24			719
234	3.	3.	0.	0.	1.	1.	0.	0.		720
235	8.	8.	0.	0.	0.	0.	0.			725
236										800
237										1000
1001	0,1,4-17,21-32,37,40,46-50,45									1001
1002	0.	0.	0.	13.5	0.015					1003
1003	40.	60.	110.3	1.	.085	201.	5.	5.		1004
1004	0.	0.	-30.	60.	-50.	20.	5.	0.		1500
1005	21.	0.	6.	0.	0.	0.	1.	0.	10.	1501
1006										1600

APPENDIX B

THREE-POINT BELT SYSTEM
BASELINE DATA SET

```
OOTVW4                                                                               100
1.        0.        32.174  0.        0.        150.      .5        1.        10.        101
3.        0.        0.        0.        0.        0.        10.       .000001 5.         102
FOOT                FLOOR                                                               106
CHEST               STEERING WHEEL                                                      106
CHEST               SEATBACK                                                            106
MID-TORSO           STEERING WHEEL                                                      106
HIP                 CUSHION                                                             106
ULEG                CUSHION                                                             106
LARM                STEERING WHEEL                                                      106
MID-TORSO           SEATBACK                                                            106
HEAD                ROOF                                                                106
LARM                INST.PANEL                                                          106
HEAD                STEERING WHEEL                                                      106
ULEG                BOLSTER                                                             106
S1SHIN              BOLSTER                                                             106
S2SHIN              BOLSTER                                                             106
S3SHIN              BOLSTER                                                             106
HEAD                INST.PANEL                                                          106
HEAD                WINDSHIELD                                                          106
0.        1.        1.        0.        0.        0.        0.        0.        0.         107
0.        0.        0.        0.        0.        0.        0.        0.        1.         108
1.        1.        0.        0.        0.        0.        0.        0.        0.         109
0.        0.        0.        0.        0.        1.        1.        1.        1.         110
0.        0.        0.        0.        0.        0.        0.        0.        0.         111
  HYBRID 3 DUMMY                                                                        200
.477      11.573    5.109     3.722     15.815              10.3      2.993     -.657      201
1.883     6.165     2.55      2.306     9.445     9.45      5.143     5.95      .1434      202
.0258     .098      .0328     .0984     .0691     .0535     .0226     .0259     .0087      203
.253      1.917     .428      1.286     1.202     3.038     .204      .632      .053       204
44.236    123.861'0.        .39812    17.394    10.                 -60.      .75        205
44.236    123.861 0.        .39812    17.394    10.                 -90.      .75        206
884.72    0.        0.        .69981    884.82    400.      20.       -50.      .75        207
102.4729-7.62075.1943356.69981    884.72    400.      -43.      -83.      .75        208
84.40653-4.80841.10522580.        884.72    400.      0.        -120.     .75        209
0.        29.815    0.        0.        221.18    100.      135.      0.        .75        210
24.391710.          .00645400.        221.18    100.      30.       -180.     .75        211
12.191430.          .00645400.        309.65    100.      3.        -145.     .75        212
4566.32   0.          0.        37.101                                                  213
684.95    0.        0.        8.0767                        1.575               1.         214
4.061     13.271    0.        .1106     19.703    8.        46.                 .8         215
4.061     17.517    0.        .0531     74.872    30.       21.5                .8         216
-15.1     -11.2     -14.2     -39.      -43.6     74.       -38.3     -63.                 217
1.898     6.2       0.                                                                  218
HEAD                                    1.        1.                                    219
CHEST               CHESTMAT            2.        1.                                    219
SLOR                                    2.        1.                                    219
MID-TORSO           CHESTMAT            3.        1.                                    219
HIP                                     4.        1.                                    219
ULEG                                    5.        1.                                    219
KNEE                                    5.        1.                                    219
S1SHIN                                  6.        1.                                    219
S2SHIN                                  6.        1.                                    219
S3SHIN                                  6.        1.                                    219
FOOT                                    6.        1.                                    219
JAW                                     1.        1.                                    219
UARM                                    7.        1.                                    219
ELBOW                                   7.        1.                                    219
```

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LARM                          8.      1.                                           219
HAND            EC3MAT        8.      1.                                           219
HEAD            .276    -.039  4.4    3.907                                        220
CHEST           -1.299  O.     4.872  4.528                                        220
SLDR            -5.187  O.     .984   2.559                                        220
MID-TORSO       -2.047  -1.063 4.331  4.331                                        220
HIP             .866    .63    4.134  4.134                                        220
ULEG            -.394   .591   8.346  2.953                                        220
KNEE            6.693   .157   2.421  2.421                                        220
S1SHIN          -4.646  .287   2.323  2.323                                        220
S2SHIN          -.287   .571   2.075  2.075                                        220
S3SHIN          3.575   .528   1.61   1.61                                         220
FOOT            6.811   -.055  4.724  4.724                                        220
JAW             3.937   -1.772 .787   1.772                                        220
UARM            -1.535  O.     4.665  2.028                                        220
ELBOW           5.039   .0787  1.929  1.929                                        220
LARM            -.0787  O.     4.035  1.821                                        220
HAND            6.339   O.     1.821  1.821                                        220
CHESTMAT        .1969   .866   O.     39.37   39.76   O.      O.                   221
CHESTMAT        33.7    O.     O.     O.      CHESTST I       CHESTGR              222
CHESTGR O.      O.                                                                 223
CHESTGR .394    .2                                                                 223
CHESTGR .866    .275                                                               223
CHESTGR 1.575   .275                                                               223
CHESTGR 2.756   .357                                                               223
CHESTGR O.      1.                                                                 224
CHESTGR .394    .48                                                                224
CHESTGR .866    .356                                                               224
CHESTGR 1.575   .352                                                               224
CHESTGR 2.756   .218                                                               224
CHESTST O.      O.                                                                 225
CHESTST .394    1191.                                                              225
CHESTST .866    1965.                                                              225
CHESTST 1.575   2739.                                                              225
CHESTST 2.756   5947.                                                              225
EC3MAT          O.      O.     O.     39.37   39.76   O.      O.                   221
EC3MAT          3.37    O.     O.     O.      EC3STAT I       EC3GR                222
EC3GR    -1.    .08                                                                223
EC3GR    -1.    .91                                                                224
EC3STAT O.      .05                                                                225
EC3STAT 1.5     530.                                                               225
EC3STAT 3.      1359.                                                              225
EC3STAT 3.6     1812.                                                              225
EC3STAT 12.     22472.                                                             225
I        -1.    O.                                                                 226
685.     O.     O.      9.047                                                      242
   HYBRID 3 DUMMY.                                                                 300
74.9     101.2  115.4   154.4  18.    -56.    -40.5   22.5    90.                  301
-6.15    O.     -12.15  O.     5.73   O.                                           303
O.       O.     O.      O.                                                         304
VEHICLE INTERIOR                                                                   400
FLOOR           MATFL          O.     1.      1.      1.                           401
INST.PANEL      MATDASH        O.     1.      1.      1.                           401
BOLSTER         MATBOL         O.     1.      1.      1.                           401
WINDSHIELD      MATWD          O.     1.      1.      1.                           401
CUSHION         MATCH          O.     1.      1.      1.                           401
SEATBACK        MATSB          O.     1.      1.      1.                           401
ROOF            MATRF          O.     1.      1.      1.                           401
```

```
 117    STEERING WHEEL  MATSTW         0.      1.      1.      1.              401
 118    FLOOR           2.      4.     1.      0.      0.                      402
 119    INST.PANEL      2.      2.     1.      0.      0.                      402
 120    BOLSTER         1.      2.     1.      0.      0.                      402
 121    WINDSHIELD      1.      1.     1.      0.      0.                      402
 122    CUSHION         1.      3.     1.      0.      0.                      402
 123    SEATBACK        1.      2.     1.      0.      0.                      402
 124    ROOF            1.      2.     1.      0.      0.                      402
 125    STEERING WHEEL  1.      5.     1.      0.      0.                      402
 126    MATFL           0.      0.     0.      1000.   2000.   2400.   8000.   403
 127    MATDASH         0.      0.     0.      1000.   2000.   0.      0.      403
 128    MATBOL          0.      0.     0.      1000.   2000.   0.      0.      403
 129    MATWD           0.      0.     0.      1000.   2000.   0.      0.      403
 130    MATCH           0.      0.     0.      1000.   2000.   0.      0.      403
 131    MATSB           0.      0.     0.      1000.   2000.   0.      0.      403
 132    MATRF           0.      0.     0.      1000.   2000.   0.      0.      403
 133    MATSTW          0.      0.     0.      1000.   2000.   0.      0.      403
 134    MATFL           2.      0.     0.      0.      FLSTAT  INERZ   FLGR    404
 135    MATDASH         2.      0.     0.      0.      DASHSTATINERZ   DASHGR  404
 136    MATBOL          2.      0.     0.      0.      BOLSTAT INERZ   BOLGR   404
 137    MATWD           2.      0.     0.      0.      WDSTAT  INERZ   WDGR    404
 138    MATCH           2.      0.     0.      0.      CHSTAT  INERZ   CHGR    404
 139    MATSB           2.      0.     0.      0.      SBSTAT  INERZ   SBGR    404
 140    MATRF           2.      0.     0.      0.      RFSTAT  INERZ   RFGR    404
 141    MATSTW          2.      0.     0.      0.      STWSTAT INERZ   STWGR   404
 142    FLGR     -1.    .2                                                     405
 143    FLGR     -1.    .2                                                     406
 144    DASHGR   -1.    .8                                                     405
 145    DASHGR   -1.    .08                                                    406
 146    BOLGR    -1.    .8                                                     405
 147    BOLGR    -1.    .08                                                    406
 148    WDGR     -1.    .95                                                    405
 149    WDGR     -1.    .01                                                    406
 150    CHGR     -1.    .1                                                     405
 151    CHGR     -1.    .85                                                    406
 152    SBGR     -1.    .1                                                     405
 153    SBGR     -1.    .85                                                    406
 154    RFGR     -1.    .5                                                     405
 155    RFGR     -1.    .5                                                     406
 156    STWGR    -1.    .95                                                    405
 157    STWGR    -1.    .05                                                    406
 158    FLSTAT   -1.    800.                                                   407
 159    DASHSTAT-1.     441.24  -109.64 9.3813  0.17045                        407
 160    BOLSTAT 0.      0.                                                     407
 161    BOLSTAT 6.      5400.                                                  407
 162    WDSTAT   -1.    2000.                                                  407
 163    CHSTAT   -1.    122.    37.6    -74.48  22.16                          407
 164    SBSTAT   -1.    14.     -9.     14.     -4.     1.                     407
 165    STWSTAT 0.      0.                                                     407
 166    STWSTAT .1      1562.                                                  407
 167    STWSTAT .49     1875.                                                  407
 168    STWSTAT .51     2500.                                                  407
 169    STWSTAT .75     1875.                                                  407
 170    STWSTAT 1.5     1562.                                                  407
 171    STWSTAT 2.4     1000.                                                  407
 172    STWSTAT 3.9     750.                                                   407
 173    STWSTAT 8.      750.                                                   407
 174    STWSTAT 10.     10000.                                                 407
```

```
175     RFSTAT  0.      0.                                                              407
176     RFSTAT  2.      2000.                                                           407
177     RFSTAT  3.      13000.                                                          407
178     INERZ   -1.     0.                                                              408
179     FLOOR           FLDDR           20.     .25     1.      1.                      409
180     TDEBDARD        FLDDR           20.     .25     1.      2.                      409
181     BOLSTERD        BDLSTER         4.      .25     1.      1.                      409
182     MIODLEDH        INST.PANEL      4.      .25     1.      1.                      409
183     UPPERDH         INST.PANEL      4.      .25     -1.     2.                      409
184     WINDSHIELD      WINDSHIELD      1.      .25     1.      1.                      409
185     CUSHION         CUSHION         20.     .25     1.      1.                      409
186     SEATBACK        SEATBACK        20.     .25     1.      1.                      409
187     RDOF            ROOF            4.      .25     1.      1.                      409
188     STEERING WHEEL  STEERING WHEEL  2.      .25     1.      1.                      409
189     FLDOR           1.                                                              410
190     TDEBOARD        1.                                                              410
191     BOLSTERD        1.                                                              410
192     MIODLEDH        1.                                                              410
193     UPPERDH         1.                                                              410
194     WINDSHIELD      1.                                                              410
195     CUSHIDN         1.                                                              410
196     SEATBACK        1.                                                              410
197     RODF            1.                                                              410
198     STEERING WHEEL  1.                                                              410
199     FLOOR           -1.     -15.    12.3    29.7    12.3                            411
200     TOEBOARD        -1.     29.7    12.3    39.2    0.                              411
201     BOLSTERD        -1.     17.5    -10.    24.7    2.5                             411
202     MIODLEOH        -1.     19.7    -6.3    21.1    -18.8                           411
203     UPPEROH         -1.     21.1    -18.8   32.     -16.2                           411
204     WINDSHIELD      -1.     32.     -16.2   15.3    -30.9                           411
205     CUSHION         -1.     -8.     5.      16.5    -2.5                            411
206     SEATBACK        -1.     -3.4    5.      -14.2   -20.                            411
207     RODF            -1.     16.     -32.9   -16.    -32.9                           411
208     STEERING WHEEL  -1.     9.7     -6.7    16.6    -20.                            411
209     1.      1.      0.                                                              412
210     1.      2.      .7                                                              412
211     1       3.      .2      0.                                                      412
212     1       4.      .8      .15                                                     412
213     1.      5.      1.                                                              412
214     1.      6.      1.                                                              412
215     CRASH 44.5 FT/SEC                                                               600
216     0.      44.5    0.      0.      0.      0.      0.      0.      0.              601
217     17.     1       0.                                                              602
218     0.      0.      5.      -1.     7.      -5.     22.     -8.
219     30.     -23.    35.     -23.    38.25   -45.28  47.     -30.
220     55.     -30.    60.     -10.    66.     0.      70.     -6.
221     90.     -12.    95.     -3.     110.    -3.     135.    0.
222     200     0.
223     PASSIVE TORSO BELT                                                              700
224     BELT            0.      0.      0.      1000.   2000.   0.      0.              704
225     BELT            20.     0.      0.              BLTST   BINERZ  BLTGR           705
226     BLTGR   -1      .05                                                             706
227     BLTGR   -1      .95                                                             707
228     BLTST   0.      0.                                                              708
228 1   BLTST   033     1000                                                            708
228 2   BLTST   125     2500                                                            708
228 3   BLTST   3       7416                                                            708
229     BINERZ  1       0                                                               709
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  229.01  H3TOP            0.       0.       0.       1000.    2000.    0.       0.                704
  229.02  H3TOP            20.      0.       0.                TOPST    BINERZ   BLTGR             705
  229.03  TOPST   0.       0.                                                                      708
  229.04  TOPST   .06      1000.                                                                   708
  229.05  TOPST   .07      6000.                                                                   708
  229.06  H3BOT            0.       0.       0.       1000.    2000.    0.  .    0.                704
  229.07  H3BOT            20.      0.       0.                BOTST    BINERZ   BLTGR             705
  229.08  BOTST   -1.      8534.                                                                   708
  229.09  STRAPMAT         0.       0.       0.       1000.    2000.    0.       0.                704
  229.1   STRAPMAT         20.      0.       0.                ABELT    BINERZ   HBELT             705
  229.11  HBELT   -1.      .05                                                                     706
  229.13  HBELT   -1.      .95                                                                     707
  229.15  ABELT   0.       0.                                                                      708
  229.16  ABELT   .04      1873.                                                                   708
  229.17  ABELT   .062     4275.                                                                   708
  229.18  ABELT   .092     6126.                                                                   708
  229.19  ABELT   .114     6647.                                                                   708
  230     2.15    2.4      -16.3    -21.3    1.0      BELT              H3TOP                      710
  231     12.     2.4                        1.0      BELT              H3BOT                      711
  231.1   3.722   0.                         1.       BELT                                         712
  231.2   3.722   0.       -7.2     10.6     1.       BELT                                         713
  231.3                    -7.2     10.6     10.      STRAPMAT                                     714
  232     3.      1.       2.       6.57     16.      1.       1.                                  717
  232.1   1.      25.      100.                                                                    718
  233                               1.                50000.   -.24                                719
  234     3.      1.       0.       3.       1.       3.       0.                                  720
  235     8.      4.71     8.       14.      6.                                                    725
  236                                                                                              800
  237                                                                                              1000
 1001     0,1,4-17,21-32,37,40,46-50,45                                                            1001
 1002     0.      0.       0.       13.5     0.015                                                 1003
 1003     40.     60.      110.3    1.       .085     201.     5.       5.                         1004
 1004     0.      0.       -30.     60.      -50.     20.      5.       0.                         1500
 1005     21.     0.       6.       0.       0.       0.       1.       0.       10.               1501
 1006                                                                                              1600
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RC 1042 .R

Robbins, D

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